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Redundancy and embedded exhaustification *

Marie-Christine Meyer
The Hebrew University of Jerusalem

Abstract I show how a formalization of Grice’s Brevity intuition, which I call Efficiency (Meyer 2013, 2014), correctly distinguishes between acceptable and unacceptable disjunctions that all seem to be redundant at first (e.g., Gajewski & Sharvit 2012; Mayr & Romoli 2013). The upshot is that the presence of embedded implicatures is one way of making a structure efficient in the formal sense developed here. I show that a particular prediction of Efficiency—the existence of embedded implicatures resulting in overall weakening of meaning—is not incorrect, and sheds new light on the role of rise-fall-rise intonation in these cases (Fox & Spector 2013; Büring 1997).

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1 Introduction

1.1 Background

The nature of scalar implicatures remains a debated topic. Some theories view the step from *some* to *not all* as an instance of rational inferences not specific to language. Others propose that the inference arises instead through a language-specific mechanism (e.g., Sauerland 2011 and references therein). Specifically, proponents of the grammatical theory of scalar implicatures assume a covert operator that strengthens the semantic denotation of its (propositional) argument by adding the negation of certain scalar alternatives. For example:

$$(1) \quad \llbracket exh [A \text{ or } B] \rrbracket = (A \vee B) \wedge \neg(A \wedge B)$$

If we accept that *exh* is available in the functional lexicon, the question arises as to what principles guide its syntactic distribution. In this paper I suggest that this is partly predicted by a constraint against redundancy, which may itself be a language-

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independent, rational principle as envisaged by Grice. The main ideas to be defended are thus the following:

- The distribution of *exh* is restricted by a pragmatic principle of Efficiency
- Efficiency rules out redundant structures if there is a simpler competitor
- Insertion of *exh* can sometimes rescue an otherwise redundant structure

1.2 Data

Consider the following two formulae:

- (2) a. $A \vee B$
 b. $A \vee (\neg A \wedge B)$

The two are equivalent.¹ But (2b) is a redundant formula given the availability of the shorter (2a). This might lead to expectations about the corresponding natural language structures, especially if we follow Grice in assuming that language use is guided by a principle constraining prolixity: We might expect a contrast in acceptability:

- (3) a. Mary studied math or she studied physics.
 b. Mary studied math or she didn't and she studied physics.

Contrary to our expectations, both the prolix and the briefer, more efficient version are licensed. In view of this, consider now a second minimal pair:

- (4) a. Mary studied math or physics or both.
 b. # Mary didn't study math or physics or both.

Both sentences seem to be redundant in the same way that (3b) is; compare the corresponding logical formulae:

- (5) a. $(A \vee B) \vee (A \wedge B) \equiv (A \vee B)$
 b. $\neg[(A \vee B) \vee (A \wedge B)] \equiv \neg(A \vee B)$

¹ The proof is trivial:

- (i) $A \vee (\neg A \wedge B)$
 $\equiv (A \vee \neg A) \wedge (A \vee B)$
 $\equiv \top \wedge (A \vee B)$
 $\equiv (A \vee B)$

But whereas (4a) is felicitous, the equally redundant (4b) sounds odd. The questions raised by the two pairs in (3) and (4) are thus:

Q: What distinguishes felicitous from infelicitous redundancy?

Q-1: Why is a seemingly redundant sentence of the form *A or not A and B* licensed?

Q-2: Why is a seemingly redundant sentence of the form *A or B or both* licensed, when its equally redundant negation *not [A or B or both]* is not?

It is beyond the scope of this paper to develop a general theory of redundancy; my goal here is to contribute to this broader agenda by addressing the two specific sub-questions stated above, thus extending some previous work in this area (Meyer 2013, 2014). To anticipate, I will argue that felicitous cases of (seeming) redundancy involve LFs that are made non-redundant by insertion of *exh*. The infelicitous cases are such that no adjunction site of *exh* would yield a non-redundant LF. This answer entails that the simple logical formulae above do not in fact capture the semantics of the corresponding sentences—it's more complicated.

2 Core proposal

Above I alluded to the Gricean intuition that language use obeys a principle of brevity. In previous work I have proposed the following formalization of this intuition:

(6) **Efficiency**

An LF ϕ is ruled out if there is a distinct competitor ψ such that (i) $\psi < \phi$ and (ii) $\llbracket \psi \rrbracket \equiv \llbracket \phi \rrbracket$

The idea is to use Katzir (2007)'s notion of structural complexity to define a set of competitors against which redundancy of a given LF is evaluated. Structural complexity is defined in terms of the 'at-most-as-complex' relation \lesssim . $\psi \lesssim \phi$ iff ψ can be derived from ϕ by substituting terminal nodes in ϕ with items from the lexicon (e.g., replace *or* with *and*), and/or substituting ϕ with a subconstituent (e.g., substitute *A* for *A or B*; see Katzir (2007); Fox & Katzir (2011); Trinh & Haida (2015) for details). ψ is *strictly* simpler than ϕ , $\psi < \phi$, iff $\psi \lesssim \phi \wedge \neg(\phi \lesssim \psi)$.

Going back to the pair in (3), we can thus ask why *A or not A and B* is acceptable, even though there seems to be a strictly simpler, equivalent competitor *A or B*. This is the first sub-question from above (Q-1), and we will address it in what follows.

Addressing Q-1 First consider the simplest LF for the complex disjunction:

(7) **LF1**

Mary studied math or [she didn't study math and she studied physics]

The competitors for such an LF include the simple disjunction:²

(8) $COMP(LF1) = \{\text{Mary studied math or she studied physics}, \dots\}$

It is easy to see that this competitor is semantically equivalent, and strictly simpler than LF1. LF1 is thus ruled out by Efficiency.

I assume a covert exhaustivity operator *exh* with the following semantics – roughly, it adds to its argument ϕ the negation of ϕ 's alternatives in keeping with consistency (I use sloppy notation in not distinguishing between object- and meta-language):

(9) $\llbracket exh \phi \rrbracket = \phi \wedge \forall \psi \in IE(\phi): \neg \psi$

(10) $\psi \in IE(\phi)$ iff $\psi \in ALT(\phi)$ and $\neg(\phi \rightarrow \psi)$ and there is no χ s.t. $\chi \in ALT(\phi)$ and $\phi \wedge \neg \psi \rightarrow \chi$ ³

Consider the definition of the set *IE* of innocently excludable alternatives: even though $A \in ALT(A \text{ or } B)$, A is not in the set $IE(A \text{ or } B)$ because $\neg A \wedge (A \vee B) \rightarrow B$, and B is itself in $ALT(\phi)$, since $B \lesssim [A \text{ or } B]$. Together, then, the standard scalar implicature of disjunction will be derived with the following LF (using transparent abbreviations):

(11) **LF2**

exh [Mary studied math or [she didn't study math and she studied physics]]

$IE = \{\perp, [\text{math and physics}]\}$ ⁴

$= \text{Mary studied math or physics} \ \& \ \neg(\text{Mary studied math and physics})$

² Recall that competitors are those structures that are strictly simpler than LF1, in the technical sense defined below (6). Roughly, competing structures are those that can be derived by substitution of terminal nodes and substitution with subconstituents in LF1. The particular competitor given below can be derived in two ways. Following Katzir 2007, we may allow for a *deletion* operation: [Mary studied math or ~~she didn't study math~~ and she studied physics]. Here I followed Fox & Katzir (2011); Trinh & Haida (2015) in only allowing for substitution with sub-constituents. To derive the above competitor by substitution, the sub-constituent [she didn't study math and she studied physics] can be substituted by its underlined subconstituent within the full structure.

³ This is a simplified semantics which, for the examples discussed in this paper, is fully sufficient. For a more fine-grained semantics see Fox (2007).

⁴ Using Katzir's algorithm, the set of structures ψ s.t. $\psi \lesssim LF2$ is the following: $ALT(\text{math or } [\neg \text{math and physics}]) = \{\text{math}, [\neg \text{math and physics}], \text{math and } [\neg \text{math and physics}] (= \perp), \dots\}$. Since the argument of *exh*, [math or [math and physics]] is equivalent to a simple disjunction *math or physics*, the only alternatives that *exh* can negate is the one given above.

Given the principle of Efficiency, this LF will only be licensed if there is no simpler competitor that expresses the same exclusive disjunctive meaning. Such a competitor does exist, however, ruling out LF2 as well:

- (12) $\mathcal{COMP}(\text{LF2}) = \{ \text{exh} [\text{Mary studied math or she studied physics}], \dots \}$
 $= \text{Mary studied math or physics} \ \& \ \neg(\text{Mary studied math and physics})$

Consider now the effect of embedded exhaustification as in LF3:

- (13) **LF3**
 $[\text{exh Mary studied math}] \text{ or } [\text{she didn't study math and she studied physics}]$

I assume that the only relevant alternative for the first disjunct is given by *she studied physics*.⁵

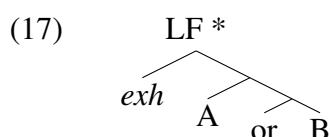
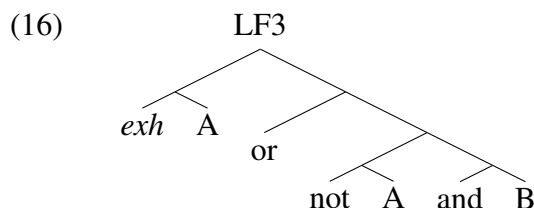
- (14) $\llbracket \text{LF3} \rrbracket = (\text{Mary studied math and not physics}) \text{ or } \text{she studied physics and not math}$

This is an exclusive disjunctive meaning. Schematically:

- (15) **LF3**
 $[[\text{exh A}] \text{ or } [\text{not A and B}]]$
 $= A \nabla B$

Is LF3 efficient? An exclusive disjunction is standardly expressed by a structure of the form *exh* [A or B], which seems to be structurally simpler than LF3. Recall that LF2 was also blocked by such a simple LF. Crucially, however, LF3 is *not* in competition with such a structure. This is because Efficiency is defined in terms of the structure-sensitive relation \lesssim : An LF ϕ will only be blocked by competitors derivable from ϕ via a restricted set of syntactic operations—intuitively, those operations which do not increase complexity. As it turns out, there is no way of generating a simpler, equivalent competitor for LF3 which satisfies these conditions. In particular, the standard LF for exclusive disjunctions is not in fact in structural competition with LF3:

⁵ There can be many other structural alternatives, e.g., *Mary got drunk*. These will not have any effect on the result. Assume that the embedded *exh* in LF3 negates further alternatives. I assume that alternatives have to stay constant across competitors when checking Efficiency. The fact remains that there will be no simpler competitor to express this meaning and that in particular, LF* is not a structural competitor. In view of additional alternatives, if it were a competitor, it would no longer be equivalent.



It is not the case that $LF^* < LF3$. According to the definition of $<$ given below (6) above, LF^* would have to be derived from $LF3$ by substitution with sub-constituents and/or lexical items. Suppose we start with the following substitution, then:

$$(18) \quad [[exh\ A] \text{ or } [not\ A \text{ and } B]] \rightarrow [[exh\ A] \text{ or } B]$$

To get to LF^* from the right-hand structure would require an additional, illicit operation, namely, the movement of the locally adjoined *exh* to the matrix position:

$$(19) \quad \curvearrowright [[exh\ A] \text{ or } B] \quad \times$$

But according to the definition of \lesssim (see (6) above), the movement operation does not preserve complexity and $LF^* \not\lesssim LF3$. It should be noted that the derivation in (18) does yield a structure that is strictly simpler than, $LF3$. But this structure is not semantically equivalent to $LF3$ and therefore not a competitor w.r.t. Efficiency.⁶

Efficiency thus correctly predicts that complex disjunctions like (3b) can be licensed. Crucially, though, this can only be achieved by (non-vacuous) embedded exhaustification. $LF3$ is thus the only licensed structure for (3b).⁷ The predicted interpretation is that of an exclusive disjunction. This prediction is empirically

⁶ Suppose, as we have done for $LF3$, that the set IE in the right-hand LF in (18) consists of just B . Then $[[[exh\ A] \text{ or } B]] = (A \wedge \neg B) \vee B = (A \vee B)$. $LF3$, however, expresses an exclusive disjunction. The same result (modulo additional implicatures for $LF3$) will be obtained when more alternatives C, D, \dots are in IE .

⁷ There is a fourth LF , which we haven't considered yet:

- (i) **LF4**
 $[A \text{ or } [not\ A \text{ and } [exh\ B]]]$
 $= A \vee B$

By parity of reasoning let the alternative for *exh* be simply A , so that $IE = \{A\}$. This will result in the inclusive disjunctive meaning shown above. $LF4$ is blocked because there is (at least) one simpler competitor that expresses this meaning:

correct, as the following data show (contra Mayr & Romoli 2013):

- (20) I'm not sure if Mary has two degrees, but. . .
- a. # She either studied math or she didn't and she studied physics
 - b. She either studied math or physics⁸

The contrast below makes the same point:

- (21) a. (Either) Mary studied math or she studied physics. . .
perhaps even both.
- b. (Either) Mary studied math or she didn't and she studied physics. . .
perhaps even both.

One might argue that (21b) is ruled out by an independent constraint on anaphoric *both*. According to this argument, the antecedent of *both* needs to be a constituent of the form [A or B] which it then turns into the corresponding conjunctive meaning. As the only available antecedent of that form yields a contradiction when conjoined (i.e., *she both studied math and didn't and studied physics*), the continuation is ruled out by this independent factor.⁹

However, if this alternative explanation were on the right track, the following minimal variation should be just as degraded as (21b), which it isn't:

- (22) (Either) Mary studied math or she didn't and she studied physics. . .
definitely not both.

Even though the possible antecedents for *both* are given in exactly the same configuration as in (21b), the continuation is felicitous. The only difference between (21b) and (22) is that the continuation in (21b) contradicts an exclusive disjunction meaning, while reinforcing it in (22). In sum, the contrast in (21), in conjunction with the observation in (22), is evidence in favor of the current proposal, specifically, the prediction that the only efficient LF for sentences like *A or not A and B* yield an

- (ii) $COMP([A \text{ or } [not A \text{ and } [exh B]]]) = \{[A \text{ or } B], \dots\}$

LF3 remains the only efficient structure for the complex disjunction.

⁸ One might object that (21) involves a confound: The first sentence signals that the speaker is not informed about the alternative [*math and physics*]. This might be said to interfere with the availability of this alternative. If this were the case, (20b) would be expected to be acceptable *a fortiori*. The infelicity of (20a) would still follow from the proposed account: With the predicted LF3, embedded *exh* only needs *physics* as an alternative to make the whole structure express an exclusive meaning, inconsistent with the first sentence in (21).

⁹ Thanks to Irene Heim for pointing out this potential objection.

exclusive disjunction meaning.¹⁰

SUMMARY Q-1 The goal of this paragraph was to find out why (3b) is licensed despite its seeming redundancy in view of the simple disjunction (3a). The principle of Efficiency was proposed as a formalization of the intuitive notion of redundancy. Applying it to the seemingly redundant structure *A or not A and B* revealed that local exhaustification is at the heart of the felicity of this structure: Parsing it as LF3 yields an exclusive disjunctive meaning. Crucially, this LF, and this LF alone, is not blocked by another way of expressing (exclusive) disjunction, specifically, it is not blocked by *exh* [A or B]. This is an important finding, insofar as it points to the limits of structural competition with respect to Efficiency: A given LF competes only with a restricted set of structures—roughly, those which can be derived by substitution with subconstituents (and lexical items), but not those which involve syntactic movement in addition.

Addressing Q-2 We will now consider the contrast from (4) above, which was noted by Gajewski & Sharvit (2012):

- (23) a. Mary studied math or physics or both.
b. # Mary didn't study math or physics or both.

I have proposed an account of the Hurford disjunction in (23a) elsewhere, to which we will return briefly at the end of the paper. Here I want to concentrate on the infelicity of (23b). As we will see, Efficiency correctly predicts that there cannot be a non-redundant LF for this sentence. Following are the candidates and the competitors that block them:

- (24) **LF1**
not [[math or physics] or [math and physics]]
= \neg (*Mary studied math or physics*)
- (25) $\mathcal{COMP}(\text{LF1}) = \{\text{not [math or physics]}, \dots\}$
= \neg (*Mary studied math or physics*)

This competitor is derived via substitution with sub-constituents and is therefore simpler than LF1. As it is also semantically equivalent to LF1, LF1 is ruled out by Efficiency. As expected, vacuous exhaustification above the negation is likewise ruled out:

¹⁰ See Meyer (2015: 16) for a proposal on propositional anaphora under which both (21b) and (22) are predicted to have an available anaphor, derived from taking the constituent [*Mary studied math or she didn't and she studied physics*] and substituting the second disjunct by its subconstituent, to obtain [*Mary studied math or she studied physics*]. The fact remains that the observed contrast between (21b) and (22) could not be due to the anaphor *both*.

- (26) **LF2**
 $exh \text{ not } [[\text{math or physics}] \text{ or } [\text{math and physics}]]$
 $= \neg (Mary \text{ studied math or physics})$

The clause below *exh* denotes the negated disjunction, as seen in LF1. All alternatives for the *exh*-operator are therefore entailed by its argument: *Mary didn't study math*, *Mary didn't study physics*, *Mary didn't study math and physics*. Therefore, no alternative can be negated without contradiction, i.e., the set *IE* is empty. The resulting meaning is thus the same as before, and so is the simpler competitor expressing this meaning:

- (27) $COMP(LF2) = \{\text{not } [\text{math or physics}], \dots\}$
 $= \neg (Mary \text{ studied math or physics})$

Exhaustification below negation, on the other hand, does have a semantic effect. An LF involving such embedded exhaustification might thus stand a chance of satisfying Efficiency:

- (28) **LF3**
 $\text{not } exh [[\text{math or physics}] \text{ or } [\text{math and physics}]]$
 $ALT([[math or physics] \text{ or } [math and physics]]) =$
 $\{[math or physics], [math and physics], \text{math}, \text{physics}\}$
 $IE = \{[math and physics]\}$
 $= \neg [(Mary \text{ studied math or physics}) \& \neg (Mary \text{ studied math and physics})]$

The meaning expressed by this LF is more complex: Mary studied either both or none of the two. But is this LF efficient, i.e., is there a simpler equivalent competitor? It turns out that there is:

- (29) $COMP(LF3) = \{\text{not } exh [\text{math or physics}], \dots\}$
 $= \neg [(Mary \text{ studied math or physics}) \& \neg (Mary \text{ studied math and physics})]$

We will discuss structures like this competitor LF, which involve weakening effects of exhaustification, in the next section. For now, it suffices to note that the structure is predicted to block LF3. Let us lastly turn to the following possible LF:

- (30) **LF4**
 $\text{not } [exh[\text{math or physics}] \text{ or } [\text{math and physics}]]$
 $IE = \{[math and physics]\}$ ¹¹
 $\neg [(math \text{ or physics}) \& \neg (math \text{ and physics})] \text{ or } (math \text{ and physics})]$

¹¹ This will be the set of excludable alternatives regardless of whether or not we include only [math and physics], i.e., the other disjunct, or the full Sauerland-set {math, physics, math and physics}.

$$= \neg (\text{Mary studied math or physics})$$

Though exhaustification is not vacuous locally, the meaning of the LF as a whole is simply that of a negated disjunction. Again, there is a competitor with the same semantics:

$$(31) \quad \mathcal{COMP}(\text{LF4}) = \{\text{not [math or physics]}, \dots\} \\ = \neg (\text{Mary studied math or physics})$$

As a consequence, LF4 will be ruled out as well.

SUMMARY Q-2 In sum, the principle of Efficiency straightforwardly derives the infelicity of negated Hurford disjunctions like (23b). As we saw, all possible parses conflict with Efficiency—there is always a simpler structural competitor. Under the current proposal, this is the source of their infelicity.

3 Extension: weakening implicatures

Efficiency does not rule out cases where structural complexity incurs semantic weakening. In particular, the principle licenses exhaustification in the scope of downward-entailing operators like negation:

$$(32) \quad \text{LF1} \\ \text{not } \text{exh} [A \text{ or } B] \\ IE = \{[A \text{ and } B]\}^{12} \\ = \neg [(A \vee B) \wedge \neg (A \wedge B)] \\ = \neg (A \vee B) \vee (A \wedge B)$$

My claim here is that LFs like (32) are indeed attested, as Efficiency predicts. Specifically, I suggest that some cases of ‘meta-linguistic negation’ (Horn 1989) are an instance of these weakening embedded implicatures.¹³ Consider (33):

¹² The specific make-up of *IE* is based on the assumption that *ALT* is the Sauerland-set. If there is another alternative for the whole disjunction, e.g., *C*, the meaning will be different. Most likely, this meaning can only be expressed with *only*, cf. *John didn't #\{only\} ask Mary or Sue... He asked Bill as well*, and not with the LF above. As we will see below, these assumptions about (32) are consistent with facts about focus-marking: For the weakening implicature to arise, the disjunction needs to receive pitch accent, which I will argue is part of a complex topic marking. I assume this indicates F-marking on *or*. Following Fox & Katzir (2011); Fox & Spector (2013), only the F-marked constituents (here: the terminal node *or*) is targeted by substitution (here: with *and*), yielding the assumed alternative set and *IE* {[A and B]}.

¹³ Horn himself pointed out that standard negation could cover his ‘meta-linguistic’ uses under the—at the time unthinkable—assumption that scalar implicatures arise during semantic computation: ‘*Such examples cannot be collapsed under Karttunen & Peter's [contradiction negation] approach with-*

(33) Mary didn't study math OR physics... she studied both!

In what follows I will sketch an account of (33) in terms of embedded exhaustification, i.e., an LF like (32). I propose a compositional account of how the characteristic intonational pattern associated with (33) disambiguates in favor of the LF in (32) (this is question Q-1). I will then discuss open issues pertaining to the role of the continuation ... *both!* (question Q-2).

Addressing Q-1 It is well-known that there is a characteristic intonational contour associated with (33). A closer look reveals that phonological focus, i.e., pitch accent on *or*, is insufficient to disambiguate in favor of the weakening implicature (contra Fox & Spector 2013):

- (34) A: Mary DIDN'T_{H*} buy the Porsche OR_{H*} the Mercedes_{LL%}.
 B: So she didn't buy any car?
 C: # So she bought two cars?

The final fall in (34) seems to re-enforce the strong reading brought about by LFs like *not [A or B]*. The weakening implicature, by contrast, requires a final rise in addition to the pitch accent. Interestingly, it seems to be the pattern associated with contrastive topics (s. Jackendoff 1972; Büring 2003):¹⁴

- (35) A: Mary DIDN'T_{H*} buy the Porsche OR_{L+H*} the Mercedes_{LH%}.
 B: ✓ So she bought two cars?
 C: # So she didn't buy any car?¹⁵

But just what is the role of the CT-contour L+H*LH% in cases like (33)? As stated earlier, my suggestion is that the CT-contour disambiguates in favor of an LF as in (32). To derive this formally, I follow Büring (2003) in assuming that the contour comes with the following inference:

- (36) At least one question in $\llbracket \phi \rrbracket^{\text{CT}}$ is left open after asserting ϕ

out incorporating conversational implicata (...) into the logical form of these sentences [emphasis mine]. *But conversational implicata by definition are not part of logical form.* (Horn 1989:370)

¹⁴ It is often assumed that the pitch accent on contrastive phrases involves a steeper rise, i.e., L+H*, which is why I marked it as such here. See e.g., Hirschberg & Pierrehumbert (1986); Watson, Tanenhaus & Gunlogson (2008). Though Horn discussed the similarity to Jackendoff's 'B-accent' he did not put forward a formal proposal about the exact semantic contribution of this contour in utterances like (33).

¹⁵ The infelicity of this follow-up question is an instance of the observation discussed below, namely, that ... *neither* continuations are impossible under CT-intonation. Given this fact, the oddness of C's reaction indicates that under the given intonation, only the weakening *not ex [A or B]* parse is available, but not the strong parse *not [A or B]*.

$\llbracket \phi \rrbracket^{\text{CT}}$ is the *contrastive topic* semantic value of ϕ and can be thought of as a set of question meanings. Looking at the LF in (32) involving the weakening *exh*-operator, we can now ask what CT-inference this LF would give rise to. As can be seen from (36), this will depend on its CT-value, which is given below (see Büring 2003 for details):¹⁶

$$(37) \quad \llbracket \text{not}_F \text{exh} [A \text{ or}_{\text{CT}} B] \rrbracket^{\text{CT}} = \{A \text{ or } B \text{ but not both?}, A \text{ and } B?\}$$

According to (36), the CT-inference associated with this LF is that either the question *whether A or B but not both*, or the question *whether A and B* are left open after the assertion, i.e., by the standard semantic value of this LF, which is given below:

$$(38) \quad \begin{aligned} \llbracket \text{not}_F \text{exh} [A \text{ or}_{\text{CT}} B] \rrbracket \\ &= \neg[(A \vee B) \wedge \neg(A \wedge B)] \\ &= \neg(A \vee B) \vee (A \wedge B) \end{aligned}$$

(38) leaves open the last question in the CT-value above, namely, *whether A and B*. This is exactly the open issue that the continuation subsequently resolves.

What happens if a sentence involving the same focus- and CT-marking is parsed without embedded *exh*? The CT-inference is predicted to be different, as is the standard semantic value:

$$(39) \quad \begin{aligned} \textbf{LF2} \\ \text{not}_F [A \text{ or}_{\text{CT}} B] \\ \llbracket \textbf{LF2} \rrbracket &= \neg(A \vee B) \\ \llbracket \textbf{LF2} \rrbracket^{\text{CT}} &= \{A \text{ or } B?, A \text{ and } B?\} \end{aligned}$$

Importantly, the CT inference brought about by the intonational contour is false under LF2. This is because the basic semantic meaning is very strong: $\neg(A \vee B)$. As such, it answers both questions in the CT-value, i.e., *whether A or B* (no!) and *whether A and B* (again no!).

The foregoing discussion is summarized in the diagram below:

¹⁶ I assume that the negation is focused, as indicated by its pitch accent. Again I use sloppy notation in that the italicized questions are short for their semantic denotations.

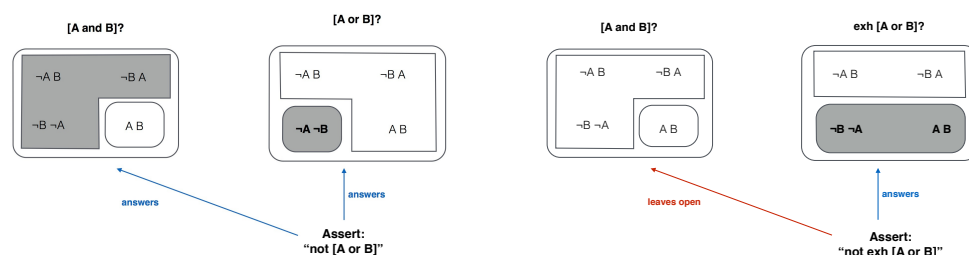


Figure 1 Does the assertion leave open a question in the CT-value? Difference between LF with embedded *exh* and simple LF.

Independent evidence that the intonational pattern comes with an inference along these lines comes from the following contrast (see Büring 2003 for detailed discussion):

- (40) Mary solved SOME_{L+H*} of the p-sets_{LH%}.
 $\square^{\text{CT}} = \{ \text{did Mary solve some of the } p\text{-sets?}, \underline{\text{did Mary solve all of the } p\text{-sets?}} \}$
- (41) # Mary solved ALL_{L+H*} of the p-sets_{LH%}.
 $\square^{\text{CT}} = \{ \text{did Mary solve some of the } p\text{-sets?}, \text{did Mary solve all of the } p\text{-sets?} \}$

In (40), the underlined question in the CT-value is still left open by the assertion, and the sentence is felicitous. But in (41), no question is left open, and the sentence sounds odd under the given contour.¹⁷

We are now in a position to formulate a hypothesis about Q-1: what is the role of the intonational pattern? As suggested by Büring (1997), CT-inferences may act as ‘a filter on LFs’ in that those structures which falsify the corresponding inference are blocked. As seen by the oddness of (41), if no other parse is available to circumvent a conflict with the CT-inference, a sentence may become infelicitous. In the case of our initial sentence *not_F A or_{CT} B*, only the LF containing embedded exhaustification satisfies the relevant CT-inference, whereas the LF without the embedded implicature does not. Thus, assuming a syntactic operator *exh*, the role of intonation in ‘meta-linguistic’ negation like (33) can be unified with the scope-reversal cases discussed by Jackendoff and Büring: via its semantic contribution, the intonational contour disambiguates between different LFs.

¹⁷ As can be seen from the CT-values, I assume that these sentences include verum focus which is not realized phonetically. Note also that the LF *exh* [Mary solved SOME of the p-sets] would conflict with the CT-inference as well, though re-interpretation as in (40) prevents the sentence from sounding odd. Lastly, a different intonational contour, with the pitch accent realized on *p-sets*, can make (41) acceptable. This is predicted given principles of focus projection (e.g., Selkirk 1995).

So far, we predict that when the contour is used, the only available LF will contain an embedded, weakening implicature. But the implication seems to hold in the other direction as well: Under the ‘meta-linguistic’ use, the only available intonation is the CT-contour, at least for the speakers I have consulted so far (s. (34)). Assume that these intuitions can be substantiated by more systematic empirical investigation. Following Roberts (1996), the CT-inference in (36) could be modeled as a presupposition, making its use subject to Heim’s *Maximize Presupposition* (Heim 1991).¹⁸

Summarizing thus far, (42) has to be parsed as LF1 given its intonation:

- (42) Mary didn’t study math OR physics_{LH%}...
 LF1: not *exh* [A or B]
 $= \neg(A \vee B) \vee (A \wedge B)$

Addressing Q-2 Semantically, LF1 is consistent with Mary having studied both subjects, and none of the two.¹⁹ The role of the continuation seems to be to fully resolve this issue. But, as illustrated below, whereas the ... *both* continuation is possible, perhaps even obligatory for (42), the equally consistent continuation in (43b) is highly marked:

- (43) Mary DIDN’T study math OR physics_{LH%}...
 a. she studied both.
 b. ?? she didn’t study anything/she studied neither.

At first it seems that this asymmetry follows from independent constraints on focus placement in contrastive negation. Specifically, if a statement v is negated and contrasted with an alternative statement α , focus-placement in v is subject to constraints that are partly determined by α (and vice versa). This is illustrated below (e.g., Rooth 1992):

¹⁸ Note incidentally that this offers the perspective of a competition between the falling contour H*LL% as in (34) and the rising L+H*LH% contour: The former would give rise to the anti-presupposition that the presupposition of the CT-inference is not met (Percus 2006; Sauerland 2008), i.e., that there are no open questions in the CT-value. For a sentence like *John ate SOME of the cookies* (with *verum* focus), the falling contour would then anti-presuppose that one question in {*did John eat some of the cookies?*, *did John eat all of the cookies?*} is left open. This, in turn, can only be satisfied if *exh* is adjoined. Reversely, with raising intonation a question in this value would have to be left open, which is only possible without *exh*. Further research is needed to establish whether the predicted correlation between falling vs. raising intonation and presence vs. absence of implicatures can be substantiated.

¹⁹ In an unpublished manuscript, Fox & Spector (2013) argue for an LF of (33) under which the sentence would have a conjunctive meaning: *Mary studied math and physics*. Under this proposal, it is unclear why the continuation ... *she studied both!* is even allowed, and even more mysterious why it would be needed.

- (44) Mary didn't INVITE_F Bill...
- a. # she invited FRED_F.
 - b. ✓ she SUMMONED_F him.

Uncontroversially, I assume that the pitch accent on OR reflects abstract F-marking on the connective,²⁰ which in turn means that the alternatives which (43) can be contrasted with are just the singleton set in (45a):

- (45) a. $ALT(A \text{ or}_F B) = \{A \text{ and } B\}$
 b. $ALT([A \text{ or } B]_F) = \{C, D, \dots\}$

The prediction is that not only ... *neither*, but also other continuations that do not obey the relevant parallelism constraint should be ruled out. This prediction is borne out:

- (46) a. Mary DIDN'T study math OR physics_{LH%} ... # she studied CHEMISTRY
 b. Mary DIDN'T study [math or PHYSICS]_{LH%} ... ✓ she studied CHEMISTRY

Though this might be an independent explanation as to why the *neither* continuation in (43b) is ruled out, it doesn't carry over to the following case, where it predicts (47b) to be acceptable:

- (47) Mary DIDN'T read SOME of the books_{LH%}...
- a. she read all of them.
 - b. ?? she read none of them.

As far as I have been able to check, (47b) is still marked when compared to (47a). I cannot provide an answer to this puzzle here, except to note that in addition to the above constraint on focus placement, another factor in the asymmetry between the two semantically possible resolutions might be the overall *QUD* that's being addressed, for instance, *What did Mary study?* or *How many of the books did Mary read?*. It has been argued that *wh*-questions carry an existential presupposition (Karttunen & Peters 1979; Comorovski 1996). An analogous requirement on the common ground might hold for *QUDs*, i.e., the current topic of conversation. In a context where *what Mary studied* is being discussed, resolving a sentence that is semantically consistent with Mary having studied neither or both of the two relevant subjects in favor of the former possibility would negate the appropriateness of the current conversational topic. Only the ... *both* resolution is in line with the relevant

20 See Krifka (2007) for the relation between CTs and F-marking.

requirement on the common ground that there is something that Mary studied.²¹

In closing this section I would like to briefly illustrate the suggestion with another DE-operator, exploring its potential to extend to weakening implicatures beyond the case of negation.

- (48) EVERYbody_F who failed the oral OR_{CT} the written exam passed. . .
but nobody who failed both did.

Consider the LF with *exh* embedded in the restrictor of the universal quantifier:

- (49) **LF1**
everybody who *exh* [failed the oral or the written exam] passed
 $\llbracket \text{LF1} \rrbracket = \forall x : [O(x) \vee W(x) \wedge \neg(O(x) \wedge W(x))] \rightarrow P(x)$
 $\llbracket \text{LF1} \rrbracket^{\text{CT}} = \{\text{how many who did } O \text{ or } W \text{ but not both passed?}, \text{how many who did } O \text{ and } W \text{ passed?}\}$

The ordinary semantic value of LF1 leaves open the last question, i.e., how many of those who failed both the oral and the written exam passed.²² By contrast, if there is no embedded *exh* the CT-inference will be false:

- (50) **LF2**
everybody who [failed the oral or the written exam] passed
 $\llbracket \text{LF2} \rrbracket = \forall x : O(x) \vee W(x) \rightarrow P(x)$
 $\llbracket \text{LF2} \rrbracket^{\text{CT}} = \{\text{how many who did } O \text{ or } W \text{ passed?}, \text{how many who did } O \text{ and } W \text{ passed?}\}$

The meaning of LF2 answers both questions. Therefore, LF1 containing weakening embedded *exh* satisfies the CT-inference, but LF2 does not. The case is thus parallel to the previously discussed example involving negation.

SUMMARY: WEAKENING IMPLICATURES In sum, the LFs involving embedded *exh* below negation or in the restrictor of a universal quantifier satisfy the inference associated with the CT-contour, but those LFs without embedded exhaustification do

21 It should be kept in mind that this line of explanation may lead to the same issues raised in the previous footnote with respect to Fox & Spector's proposal: Together with this requirement ('presupposition') of the *QUD*, the sentence would come to mean that Mary studied math and physics. The redundancy (!) of the . . . *both* continuation would again be puzzling. Differences in the level of meaning might play a role here, namely, whether the conjunctive meaning corresponds to the semantic denotation (as in Fox & Spector's proposal) or whether it is derived from context in conjunction with the semantics.

22 The additional scalar implicature that $\neg(\text{everybody who failed the oral and the written exam passed the class})$ would not answer the question either (it could be no students or some). Under the grammatical view taken here, this implicature would be derived by an additional *exh* in matrix position. As a consequence, the intonational contour does not rule out such an LF, as long as there is also an embedded *exh*.

not. Why is the CT-contour required for weakening implicatures as in LF2? This concerns the status of the CT-inference: It might be a presupposition, positioning the obligatory intonational marking of weakening implicatures within the scope of Heim's *Maximize Presupposition* principle (Heim 1991). This, however, conflicts with evidence suggesting that CT-intonation is not obligatory when it is used to signal discourse structure (s. Meyer, Fedorenko & Gibson 2012). Further research is needed to establish (i) whether intonational marking of weakening implicatures is in fact obligatory and (ii) at what level of meaning the CT-inference is located.

4 Outlook: back to Hurford

In section 2 we saw how the infelicity of (51b) follows from Efficiency: For all possible LFs, there exists a simpler equivalent competitor which blocks it. By the same logic, we expect to find at least one LF which satisfies Efficiency for (51a), as the sentence is felicitous:

- (51) a. Mary studied math or physics or both.
b. # Mary didn't study math or physics or both.

However, it turns out that all possible LFs for (51a) are blocked by a simpler competitor. To briefly illustrate this, consider two possible LFs for (51a):²³

- (52) a. **LF1** [[A or B] or [A and B]]
b. **LF2** [*exh*[A or B] or [A and B]]

The meaning of these two LFs is $A \vee B$. Both are blocked by the same competitor:

- (53) $\mathcal{COMP}(\text{LF1}, \text{LF2}) = \{[A \text{ or } B], \dots\}$

Likewise, $\text{LF3} = \text{exh}[[A \text{ or } B] \text{ or } [A \text{ and } B]]$ will have the meaning of an exclusive disjunction, but will be blocked by the competitor *exh*[A or B].

Therefore, whatever the correct LF will turn out to be (and its felicity tells us that there must be one), the prediction is that (51a) will not have a standard inclusive or exclusive disjunction meaning. In previous work I argued that this is in fact a correct prediction, because the meaning of (51a) (semantically) conveys true ignorance²⁴ with respect to the corresponding conjunction and thereby differs from simpler

23 As stated earlier, I do not want to commit to the claim that *both* is represented as a full conjunctive phrase at LF; for present purposes it suffices to make the innocuous assumption that its meaning is equivalent to [A and B].

24 By true ignorance I mean uncertainty that is inconsistent with certainty about the corresponding negation. Simply put: $\neg K(\phi) \wedge \neg K(\neg\phi)$, as opposed to $\neg K(\phi)$, i.e., uncertainty about ϕ , which is consistent with $K(\neg\phi)$.

disjunctions (see Meyer 2013: ch. 2.3 for details).

We now have two observations: First, (51a) is felicitous despite blocking competitors for both the inclusive and the exclusive disjunction meaning. Secondly, (51a) has a meaning component which distinguishes it from standard (inclusive or exclusive) disjunction: true ignorance about the conjunction. Here I would like to offer the following perspective on these observations. I suggest that the ignorance inference about the conjunction arises as a rescue strategy to make (51a) efficient after all. In other words, the only way (51a) can avoid blocking by a simpler competitor is to somehow acquire the observed true ignorance meaning. My claim as to how this comes about is this:

- (54) **Rescuing by K**
 An operator *K* expressing doxastic necessity relative to the speaker can be inserted at matrix position²⁵

Simply adjoining a matrix *K* won't result in an efficient LF for (51a).²⁶ Rather, Efficiency predicts exactly one possible LF for the sentence, which involves embedded exhaustification:

- (55) **Efficient LF for (51a)**
 $exh\ K\ [exh\ [A\ or\ B]\ or\ [A\ and\ B]]$
 $= K(A \vee B) \wedge \neg K(A \wedge B) \wedge \neg K \neg(A \wedge B)$

As shown, the meaning of this LF indeed entails true ignorance with respect to *A* and *B*. But if *K* can be parsed at matrix position to rescue otherwise inefficient structures, can we still derive the infelicity of the structure we started out with, i.e., # *not [A or B or both]*? It turns out that *K* will not be able to rescue this sentence: All possible configurations of *K* and *exh* have a simpler equivalent competitor.²⁷

Here I cannot develop the envisaged rescuing account for (51a) in more detail. A crucial ingredient will be independent arguments for the existence of the proposed *K*-rescue strategy. Indeed, a doxastic universal operator has been assumed precisely

²⁵ I assume that *exh* may outscope *K*.

²⁶ For instance, just adjoining it without exhaustifying will yield $LF4 = K[[A\ or\ B]\ or\ [A\ and\ B]]$. As is obvious, this LF will be blocked by the simpler $K[A\ or\ B]$.

²⁷ This is illustrated for the least obvious candidate LF below:

- (i) **LF1** $exh\ K\ not\ exh\ [[A\ or\ B]\ or\ [A\ and\ B]]$
 $= K[\neg(A \vee B) \vee (A \wedge B)] \wedge \neg K(\neg(A \vee B)) \wedge \neg K(A \wedge B) \wedge \neg K(A \vee B)$
- (ii) $COMP(LF1) = \{exh\ K\ not\ exh\ [A\ or\ B]\}$
 $= K[\neg(A \vee B) \vee (A \wedge B)] \wedge \neg K(\neg(A \vee B)) \wedge \neg K(A \wedge B) \wedge \neg K(A \vee B)$

in this role in accounts of such diverse phenomena as Free Choice disjunction, modal indefinites and modal auxiliaries, among others (e.g., Kratzer & Shimoyama 2002; Alonso-Ovalle 2006; Hacquard 2010).

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Marie-Christine Meyer
Language, Logic and Cognition Center
The Hebrew University of Jerusalem
Mount Scopus
91905 Jerusalem
macrst@alum.mit.edu